(12) UK Patent Application (19) GB (11) 2 176 929 A

(43) Application published 7 Jan 1987

(21) Application No 8614231

(22) Date of filing 11 Jun 1986

(30) Priority data

(31) 3520855 (32) 11 Jun 1985 (33) DE

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(51) INT CL[4]
H01M 6/46

(52) Domestic classification (Edition I):
H1B 646

(56) Documents cited
GB 1209336

(58) Field of search
H1B
Selected US specifications from IPC sub-class H01M

(54) Galvanic cells

(57) A galvanic cell featuring pressure contacting and consisting of electrode plates 1, 2 disposed to alternate with interposed separators 3 and wherein the terminal pillars 4, 5 serve to press together and establish contact between the group of plates. The electrodes consist of fibre material between which in the contact zone is compressed to 10 to 40% of the original thickness and wherein in the region of the throughbore in an electrode of opposite pole between two contacted electrodes, the free intermediate space between the terminal pillars and the electrode of opposite pole is fitted substantially by a layer of insulating material 10. Provided at the ends of the current-carrying members are springs which press the group of electrodes together independently of the pressure exerted for establishing the contacts.

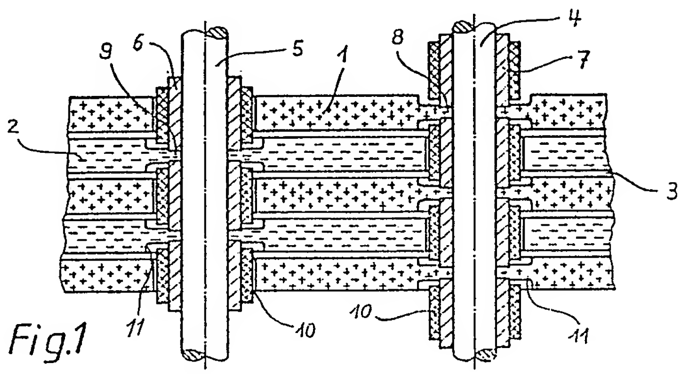

Fig.1

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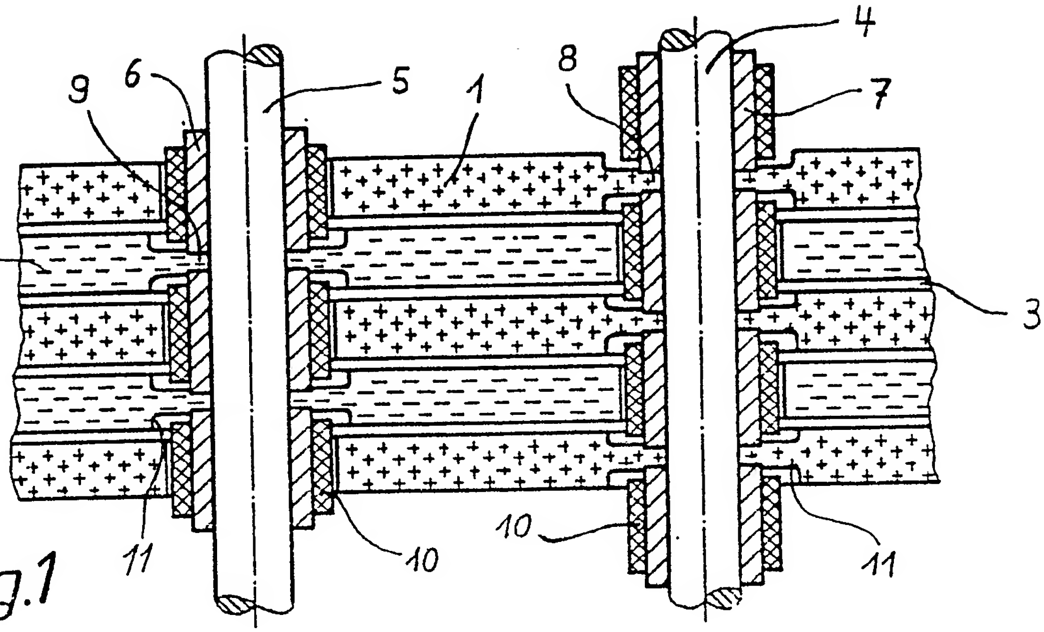


Fig.1

Fig.2

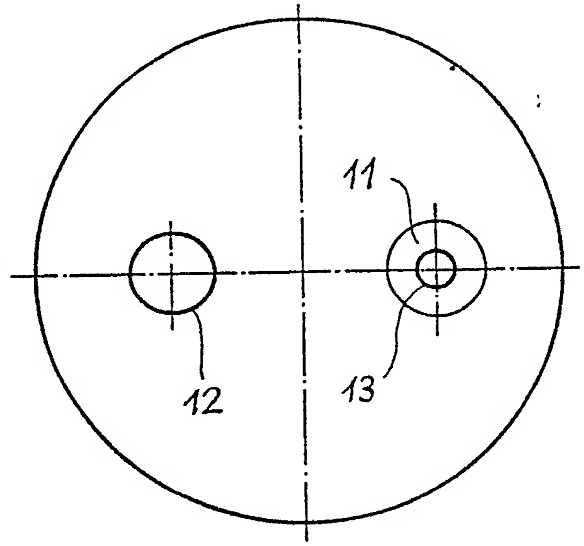
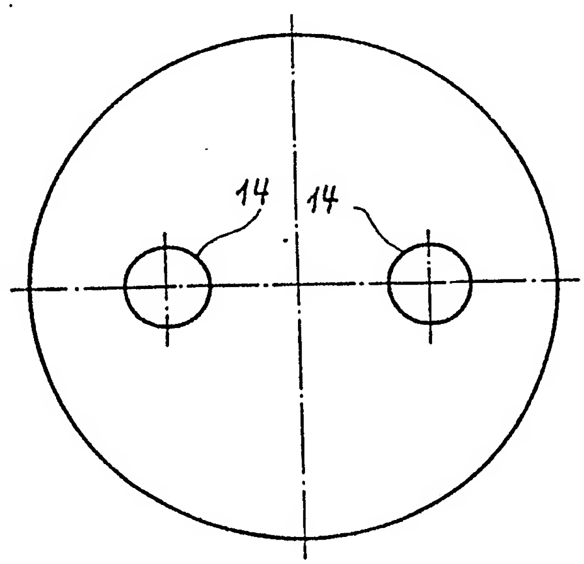


Fig.3



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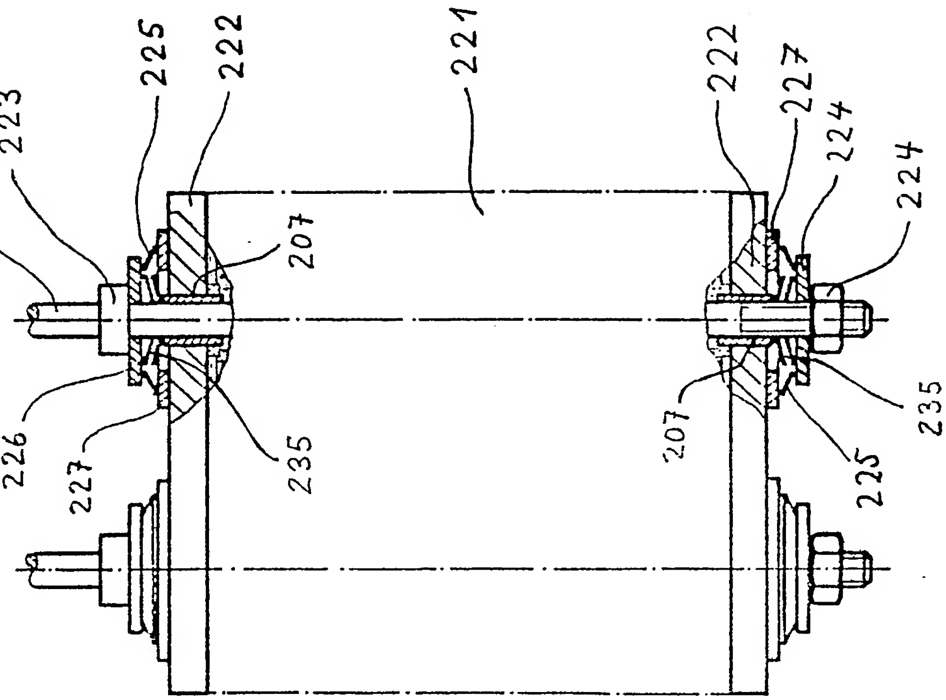


Fig.5

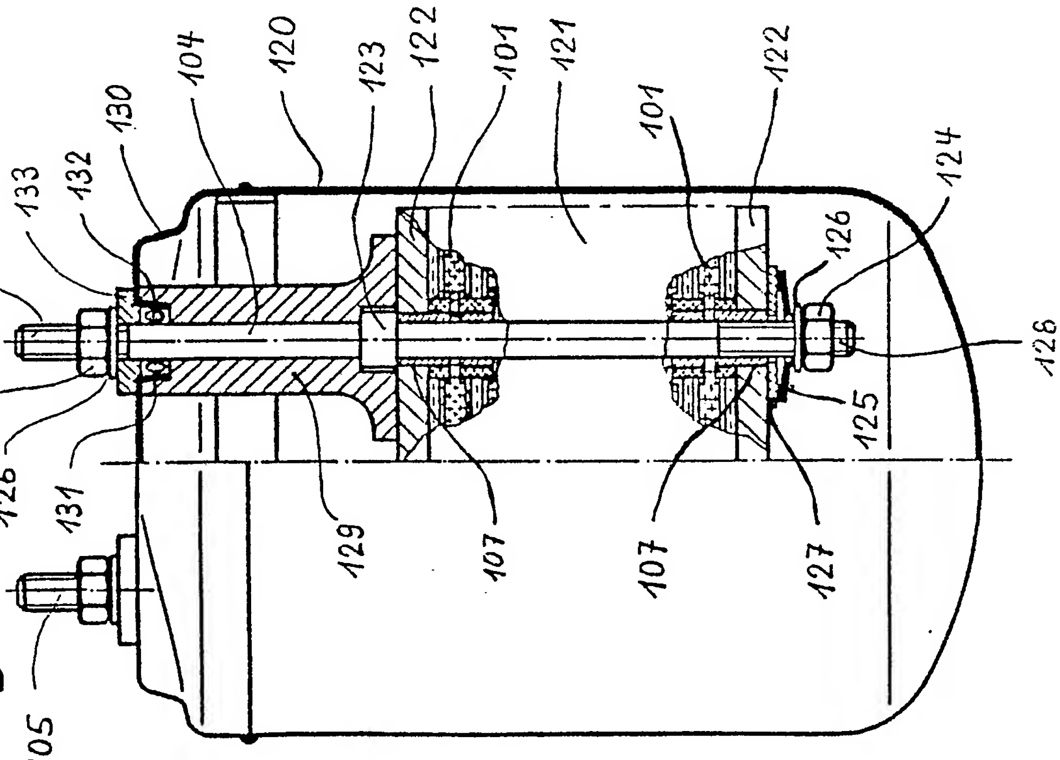


Fig.4

Fig.6

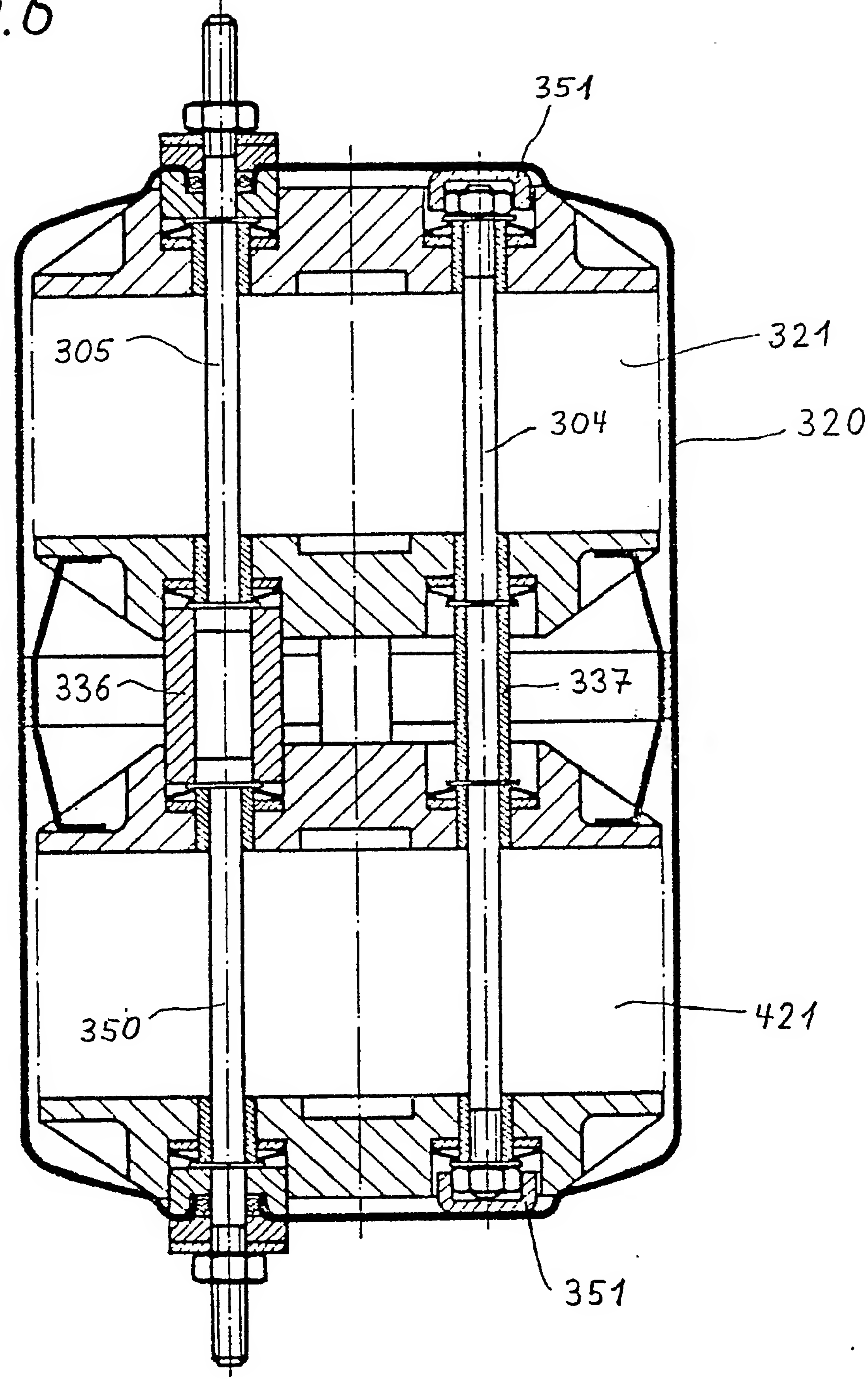
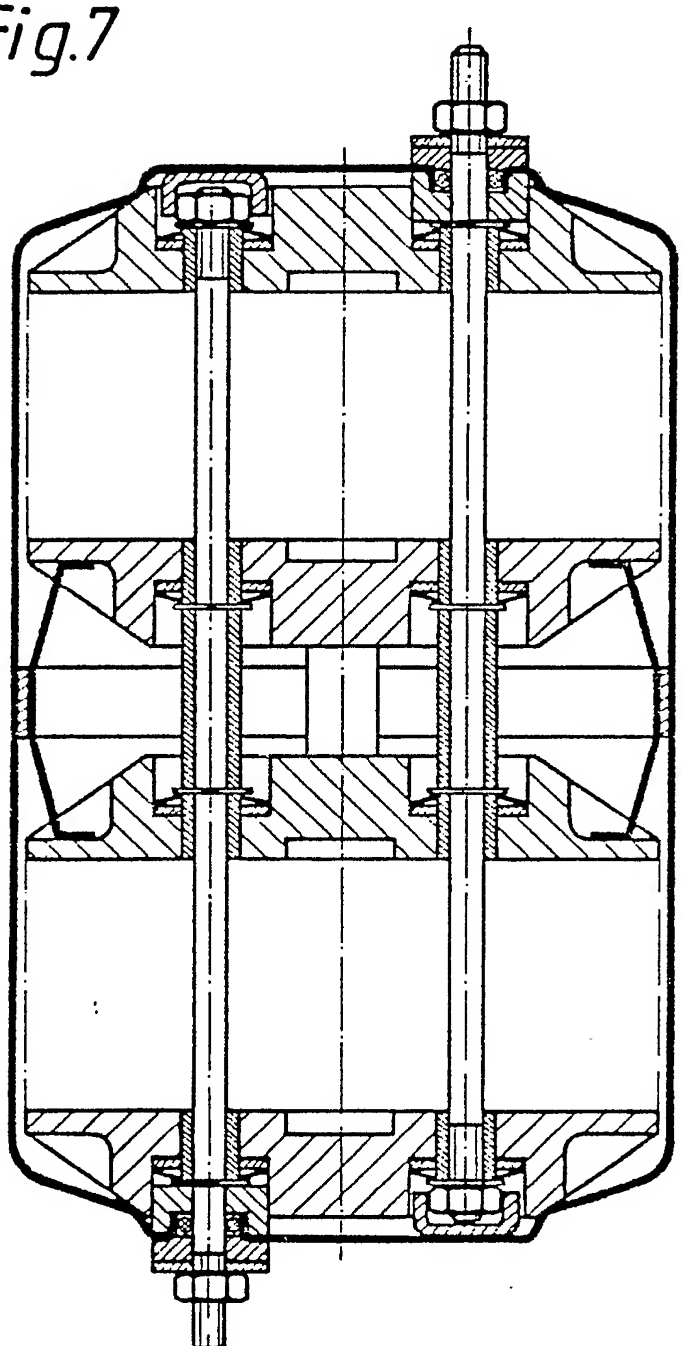


Fig.7



SPECIFICATION

Galvanic cells

This invention relates to galvanic cells. A major problem when manufacturing galvanic cells, particularly of accumulators with alkaline electrolytes, is the electrical connection between the electrode plates, the plate lugs and terminal pillars which project from the cell or from the accumulator.

These connections must on the one hand offer the lowest possible electrical resistance and on the other have high strength properties. Furthermore, the terminal pillar must be electrically insulated and sealed in relation to the housing.

With conventional construction, sheet metal lugs are spot welded to the electrode plates and are in turn mounted on terminal bridges and/or terminal pillars by screwing or welding. Difficulties arise because both the electrode frames and plate lugs have different cross-sections and material properties while the cross-sections of the plate lugs and of the terminal bridges or the terminal pillars differ greatly. Making these connections calls for very complicated apparatus and inspection techniques and is therefore very expensive.

Particular difficulties arise if instead of sintered electrodes, fibre structures are used, particularly those in which the plastics core of the fibres has not been removed.

German Patent Application No. P 39 477 IVa/21bD (Class 21b, Group 7/01) discloses a galvanic cell comprising sintered electrodes for low currents, in which the contact pillar is forced into a hole in the electrode at a right-angle to the electrode surface. The hole diameter is smaller than the diameter of the contact pillar and is provided with radial slots so that when the pillar is forced in a radial clamping effect is achieved and so contact is established, the said contact being assisted by small tubes pushed onto the contact pillars so that their end faces have inwardly directed conical faces pressing on the edges of the contact surface. To achieve an insulation between the alternately stacked positive and negative electrodes, the electrode is provided with a larger hole around the opposite polarity terminal which is disposed parallel with the terminal described, so that no contact can be established at this point. The electrode pushed over or under it is disposed in such a way as to be rotated through 180° in the same plane, so that the positive electrodes are associated with one terminal while the negative electrodes are associated with the other terminal, the electrodes being isolated from one another.

When assembling such cells, however, difficulties are created for example by virtue of the fact that an electrode can rotate about the pillar which makes contact with it. Then, in fact, also the rim of the larger hole comes in contact with the opposite/polarity terminal creating a short circuit which will destroy the cell. To prevent this, the housing must be very narrow around the cells and be of insulating material such as synthetic plastics material in order to avoid short circuits due to contact with the cell wall, as disclosed in the aforesaid German Patent Application. In the case of cell systems which are subject to elevated gas pressure, (e.g., nickel-hydrogen cells), however, this is impossible for reasons of strength. Such systems require a metallic housing.

In the case of a contact stack of group of cells, the invention is based on the problems of securing perfect contacts between electrodes of like polarity and consisting of fibre material, the said contacts also being reliable when there are fluctuations in electrode plate thickness between the charged and discharged conditions, perfect insulation being guaranteed between the differing polarity electrodes and good inner centring of the cell parts in relation to one another so that even with optimum space utilisation metallic cell housings can be used. In addition, it is intended that the least possible outlay on equipment be required in order to produce groups of cells.

According to the present invention there is provided a galvanic cell featuring pressure contacting and consisting of

a. electrode plates disposed alternately with interposed separators each of which is provided

a1. with an aperture (contact hole) of substantially the same cross-section as the current carrying member and

a2. an aperture of larger cross-section (throughbore) and in which

a3. the throughbores are provided with a border of more densely compressed material,

wherein the electrode plates

b. are so held together or pressed together into a group of electrodes by means of two bolt-like current carrying members which traverse the contact and insulating holes that the electrodes of one polarity are conductively connected to the current carrying member in the contact holes and are isolated by an insulating gap in relation to the electrodes of opposite polarity and the other current carrying member which traverses the throughbores and

c. there is disposed on the current carrying member between the fixing holes of two electrodes of like polarity in the throughbore of the interposed electrodes of opposite polarity a corrosion resistance sleeve which presses on the edges of the contact holes, and wherein

d. the electrodes consist of fibre material which in the region of the contact hole is compressed to 10 to 40% of the original thickness and

e. in the region of the throughbore between the electrodes of opposite polarity and the portion of the sleeve which presses on the edges of the contact holes, there is a layer of insulating material which substantially fills the free intermediate space between the portion of tube and the electrode of opposite polarity and the axial length of which is shorter than the axial length of the piece of tube, and

f. at the ends of the current carrying members there are springs which press the group of electrodes together regardless of the pressure on the sleeves.

Thus, the invention uses electrode frames of fibre material, wherein the fibre material in the region of the contact hole in compressed to 10 to 40% of the original thickness prior to being filled or impregnated with activated composition. Furthermore, in the region of the throughbore between the opposite/ polarity electrode and the portion of tube pressing on the edges of the contact holes, there is a layer of insulating material which substantially fills the free intermediate space between the portion of tube and the opposite-polarity electrode, the axial length thereof being shorter than the axial length of the portion of tube. Furthermore, there are at the ends of the current carrying members springs which press together the group of electrodes regardless of the pressured on the portions of tube.

The electrodes each have two holes through which pass the positive and negative terminal pillars, with one (throughbore) which is large in comparison with a terminal pillar and a smaller hole which corresponds substantially to the diameter of a terminal pillar. Contacting occurs at this smaller hole through the portions of tube pushed onto the terminal pillars, while the wide hole serves as a means of insulation from the corresponding terminal pillar and the portion of tube pushed onto it. In the region of the small holes (contact holes) which serve for contact making purposes, the fibre material of the electrode is compressed down to approx. 10 to 40% of its original thickness. A compression of the electrode frame of, for example, 40% has the advantage of better adaptability due to better inherent resilience, which is of advantage if, for instance, many electrodes are used but it also has the disadvantage of poorer contact making. A very high compression, for example down to only 10% of the originl thickness, does indeed produce outstanding contacts but requires high accuracy of the structural components of the group or stack and high pressing forces which have to be applied by the terminal pillars. Particularly good results with regard both to contact and also spring capacity are achieved by compression to 30 to 20% of the original frame thickness.

In the battery, the individual positive and negative electrodes are disposed alternately in a group with interposed separators. Between any two electrodes of like polarity which are connected to the terminal pillar by the portion of tube pushed onto the corresponding contact pillar and pressing on the edges of the contact holes, there is in each case an electrode of opposite polarity which, at the point where the terminal pillar and the small tube of the other two electrodes are located, is provided with the large hole already mentioned. In order to avoid the electrodes of opposite polarity being accidentally displaced at the time of assembly so that they might occasion a short circuit, there is in the region of the large throughbore between the opposite-polarity electrode and the portion of tube pressing on the edges of the contact holes a layer of insulating material which substantially fills the free intermediate space between the portion of tube and the opposite-polarity electrode. This layer of insulating material may consist of a sleeve of insulating material pushed over the portion of tube but it may also be a layer of enamel or synthetic plastics material applied directly onto the portion of tube. By virtue of the fact that the free intermediate space is filled by the layer of insulating material, not only is the possibility of a short circuit effectively prevented but also the clearance available for any shifting of components is reduced so that there is an additional accurate positional fixing of the individual electrodes. This fixing is particularly advantageous since the outside dimensions of the electrode block can in this way be maintained within particularly narrow tolerances which makes it possible to achieve particularly good space utilisation also with metallic housings. In this connection, it is very advantageous to provide the separators with holes, the diameter of which corresponds substantially to the throughbore of the electrodes, so that also the separators can be very satisfatorily centred or fixed in their position in relation to the electrodes.

To ensure that after assembling a group of cells, when in the main tightening up the portions of tubes (contact sleeves) these latter penetrate the compressed area of the electrode, the insulating sleeves which are pushed over the contact sleeves should in their axial length be somewhat shorter then the contact sleeves. At the same time, they must not be too short so that during assembly the disc-like thin components (e.g., the separators) cannot slip sideways. It is particularly advantageous to maintain a shortening of the length of the insulating sleeves of about 5 to 10% compared with the length of the contact sleeves so that instead of the insulating sleeves it is also possible to apply a layer of suitable insulant to the contact sleeves. For this reason, the above-described compression of the fibre material in the region of the contact hole should in its area spread be sufficiently large that it corresponds at least to the outside diameter of the insulating sleeve but should preferably be somewhat larger. Furthermore, by virtue of the difference between the contact sleeve diameter and the diameter of the compressed zone, a type of resilient membrane is created which admits of a certain mobility in the direction of the pillar axis which, when the battery is in operation, is advantageous with regard to expansion and contraction of the electrodes. A further advantage of compressing the fibre material at the contact point is gained in that upon subsequent penetration of the activated composition, less activated composition enters in this location which provides on the one hand a saving of activated composition and on the other prevents any possible impairment of contact.

It is known that when operating galvanic cells with electrolyte bonded in the separator, a certain pressure has to be applied to the surface of the group of electrodes. This is the case particularly with hybrid cell systems such as, for example, nickel-hydrogen cells. This pressure is normally applied to the group of electrodes through the end plates by tie rods.

In the case of the present galvanic cell which features prssure contacting, this tie rod function is taken over by the terminal pillars. Thus, only one component is needed to achieve the pressure to hold the group together, the pressure to establish contact and also the means of carrying current, quite apart from the already-mentioned centring of electrodes and separators.

In order to achieve satisfactory contacting of the electrodes by the contact sleeves, the clamping effect at the contact point should be as firm as possible. Pressures at the contact point of at least 50N/mm² have been found to be particularly suitable. This is achieved in that a corresponding pressure is exerted on the last contact sleeve by means of a nut screwed onto the terminal pillar.

Since as already mentioned an electrode changes its thickness during the operating cycle (charging, discharging), if the construction is too rigid and suppresses any variation in thickness, displacement of the electrolyte in unfavourable areas can cause the cell to deteriorate. To ensure opportunity for the electrodes to move in the direction of their thickness, therefore, independently of the pressure acting on the tube portions (contact sleeves), springs are provided which allow the group of electrodes to be under a certain initial tension. These springs may likewise be braced against the nut. The pressure exerted on the group of electrodes by these springs amounts to about 0.05 to 0.4 N/mm², which means that it is therefore substantially below the pressure applied at the contact point. The variation in thickness of the group of electrodes lies within the range of about 1 to 3%.

When assembling cell groups with a very large number of electrodes, the danger may arise that in course of time the contact points at the electrode frames may creep somewhat and thus offer higher transition resistance to the contact sleeve. It is possible successfully to counteract this disadvanage by inserting Belleville spring washers between the contct sleeves and the terminal pillar ends (nut). These Belleville spring washers must be disposed parallel with the springs holding the group of cells and be designed according to the differing force conditions. Taking into account two terminal pillars and the pressures indicated earlier, and the areas for cell group and contact zones, so there is a ratio of contact pressure force to halve the group pressure force of approx. 1:1 to 5:1. Such an arrangement then makes it possible for the two directions of movement between cell group and contact zone even to extend opposite each other without thereby damaging the essential conditions for perfect working of a cell group. For optimum adjustment of the pressures applied and contact making it is favourable if, for example, one end of the terminal pillar comprises a shoulder in the region of the end plate while the other end carries a screwthread.

Advantageously, the terminal pillars are simultaneously used to support the cell group on the cell housing. In this case it is ideal to lengthen the terminal pillar after the shoulder and to provide this part likewise with a screwthread. The two parallel disposed terminal pillars can then be passed through correspondingly constructed apertures in the housing and be clamped in both electrically insulated and also seal-tight fashion to the housing by suitable means. It is thereby readily possible for one terminal pillar to pass through at one end of the cell housing while the other terminal pillar passes through at the opposite end of the cell housing which, as is well known, gives rise to satisfactory conduction of current in a cell.

A particular advantage arises if, for example, two groups of cells are to be connected one behind the other (Bi-cell) in one housing. In this case, one terminal pillar may pass through both groups and, with corresponding contacting within the group, constitute the pole connector between the groups. The two other parallel disposed terminal pillars are passed separately and in opposite directions out of the groups and are the two terminal poles of Bi-cell.

By way of example, a cell group featuring axial pressure contacting and also cell group dispositions of galvanic cells according to the invention are illustrated in the accompanying drawings, in which;

Figure 1 is a longitudinal sectional view of an electrode group;

Figure 2 is a plan view of an electrode frame;

Figure 3 is a plan view of a separator;

Figure 4 is a view with partial longitudinal section through a complete cell comprising spring elements for the group;

Figure 5 shows an electrode group with spring elements for the group and also for making contacts by pressure.

Figure 6 shows the construction of a gas-tight Bi-Cell; and

Figure 7 shows the construction of a cell having parallel connected groups of electrodes.

Figure 1 shows the enlarged detail of a cell group with terminal pillars passing through it. As shown, the positive electrodes (positives) 1 and the negative electrodes (negatives) 2 are stacked alternately. Incorporated between the electrodes are separators 3. The positives 1 are associated with the right/ hand terminal pillar 4 and the negatives 2 are associated with the left-hand terminal pillar 5.

The tubular contact sleeves 6 pushed over the left-hand pillar are diposed between the negatives while the contact sleeves 7 pushed over the right-hand pillar are disposed between the positives. By virtue of the axial pressure applied, the contact sleeves penetrate somewhat into the contact zones 8, 9. Fitted over the contact sleeves are insulating sleeves 10.

In their length, they are somewhat shorter than the contact sleeves. Instead of the insulating sleeves, a suitable coating may be applied to the contact sleeves.

The previously compressed zone 11 on the electrodes in the region of the contact hoel 13 is of somewhat larger diameter than the outside diameter of the insulating sleeves.

Figure 2 show the plan view of an electrode. The

larger left-hand hole 12 (throughbore) corresponds to the diameter of the insulating sleeve and the smaller right-hand hole 13 (contact hole) corresponds to that of the terminal pillar. The zone 11 around the smaller hole is on both sides pressed symmetrically into the electrode.

Figure 3 shows a plan view of a separator 3. The two holes 14 have the same distance between centres as do the electrode holes and their diameters both correspond to the outside diameter of the insulating sleeves 10 or throughbores 12.

Figure 4 shows a view with a partial longitudinal section through a complete gas-tight cell (e.g., Ni/H). The cell group 121 is concentrically mounted in the metallic container 120 by means of terminal pillars 104 and 105. The cell group is covered at top and bottom by respective end plates 122 of insulating material and is clamped between the shoulder 123 and the nut 124. In order to guarantee a definite stack movement, a Belleville type spring washer 125 is inserted between the lowe end plate and the nut. This is braced on the side of the nut on a shim 126 and on the end plate side it is braced against a further shim 127. The end contact sleeves 107 which establish the contact between the terminal pillar 104 and the last positives 101, are passed through the insulating end plates 122 and are braced at the top against the shoulder 123 and at the bottom against the shim 127. The terminal pillar has at its bottom end a screwthread 128. Thus a controlled pressure on the group 121 can be adjusted by the nut 124 and the Belleville spring washer 125.

Slipped over the upper part of the terminal pillar 104 is a spacer 129 which consists of plastics material. It serves to brace the group of cells against the container cover 130. Since the interior of the cell is subject to high pressure (e.g. 40 to 50 bars) and the terminal pillar 104 has to be electrically insulain respect of the cell cover 130, the cell cover is provided with an opening with an inwardly directed flange 131 through which the terminal pillar passes. Between the flange 131 and the terminal pillar 104, an O-ring 132 is pressed into place. It provides both for insulation and also for sealing. So that the O-ring cannot be pressed outwards by gas pressure, the top of the cover is covered with a sheet 133 of insulating plastics material. In the region of the radius at the flange, it projects somewhat into the latter. The upper part of the spacer 129 is so recessed that the flange 131 just fits into it. Thus, the O-ring is so to speak enclosed in an annular space. For clamping purposes, the upper part of the terminal pillar is likewise provided with a screwthread 134 but this must stop above the O-ring as otherwise sealing-tightness is jeopardised. Clamping between the interior parts of the cell and the cell container can be achieved by a further nut 124, a shim 126 being fitted between it and the plastics plate 133.

This construction permits of and guarantees accurate centring of the cell group in relation to the housing, rigid support, simple but perfect sealing, good current dissipation and at the same time very simple cell assembly.

The example shown in Figure 4 relates to a cell comprising a relatively short cell group. If, however, for reasons of greater capacitance, a very long cell group is necessary, then difficulties may occur between matching the pressure of the cell group and that of the contact sleeves. To counteract this, Figure 5 shows a cell group 221 in which the end contact sleeves 207 and the end plates 222 are in each case braced by separate spring means. The Belleville spring washer 225 for the group are softer than the plate springs 235 for the contact sleeves and are connected to one another in parallel. For bracing the Belleville spring washers 225 and 235 on the shoulder 223 or on the nut 224 of the terminal pillar 204 and for bracing the spring 225 on the synthetic plastic end plate 222, metal discs 226 and 226 are interposed.

These spring arrangements are provided at both ends of the group and the terminal pillars so that all in all greater elasticity and even pressure and movement of the cell group can be guaranteed.

Figure 6 show a Bi-cell. This is a cell in which the group of electrodes is connected in series, the electrodes being accommodated in a housing 320. Thus, the cell voltage is doubled and yet only two terminal pillar bushings are required, as with a single cell. In this case, the left upper terminal pillar 305 is only connected to the upper cell group 321 while the right-hand terminal pillar 304 passes through both groups. The left-hand lower terminal pillar 350 is in turn only in contact with the lower cell group 421. The positive electrodes of the upper group 321 contact the left-hand upper terminal pillar 305 and the negative electrodes contact the upper part of the terminal pillar 304 which passes through. The case is exactly the opposite with the lower cell group. Thus, the terminal pillar passing through represents the cell connector for both cell groups. The terminal pillar 305 which is passed through the upper part of the cell 320 serves as positive connecting terminal and the lower terminal pillar 350 serves as a negative connecting terminal.

The sleeve 336 is of synthetic plastics material and serves at the same time as a centring and spacing member, while the metallic intermediate contact sleeve 337 serves as a support for pressing together the contact sleeves (not shown) in the group and as a means of carrying current. With an eye to simplifying manufacture, it is also possible for the intermediate contact sleeve to be composed of a plurality of contact sleeves, so long as the dimensions of the contact sleeves permit this. The caps 351 of the ends of the terminal pillar 304 are of an elastomer and brace the cell group in relation to the cups in the cell container.

Figure 7 shows by way of example a gas-tight hybrid cell in which two groups of electrodes are connected to each other electrically in parallel and are accommodated in a common housing. The two terminal pillars extend in each case through both cell groups and are insulated from each other and are passed diametrically in relation to each other at one end through the cell container. All electrodes of both groups which are associated with one ter-

minal pillar have electrically the same polarity. Such a cell arrangement is advantageous with regard to heat dissipation from the groups and with regard to welding of the cell housing parts.

By means of the pressure contact construction described, it has been possible easily to satisfy many requirements such as contacting, centring, supporting and proper chamber filling, while at the same time permitting of keenly priced manufacture.

It will be readily appreciated how complicated and time-consuming a construction would be if, instead of pressure contacting, each individual electrode were to be provided with a plate lug, these plate lugs then having to be connected to one another and with those of a second group and the cell terminals, quite apart from the fact that additional holders would be required for the cell groups.

CLAIMS

1. A galvanic cell featuring pressure contacting and consisting of

a. electrode plates disposed alternately with interposed separators each of which is provided,

a1. with an aperture (contact hole) of substantially the same cross-section as the current carrying member and

a2. an aperture of larger cross-section (throughbore) and in which

a3. the throughbores are provided with a border of more densely compressed material,

wherein the electrode plates,

b. are so held together or pressed together into a group of electrodes by means of two bolt-like current carrying members which traverse the contact and insulating holes that the electrodes of one polarity are conductively connected to the current carrying member in the contact holes and are isolated by an insulating gap in relation to the electrodes of opposite polarity and the other current carrying member which traverses the throughbores and

c. there is disposed on the current carrying member between the fixing holes of two electrodes of like polarity in the throughbore of the interposed electrodes of opposite polarity a corrosion resistance sleeve which presses on the edges of the contact holes, and wherein

d. the electrodes consist of fibre material which in the region of the contact hole is compressed to 10 to 40% of the orginal thickness and

e. in the region of the throughbore between the electrodes of opposite polarity and the portion of the sleeve which presses on the edges of the contact holes, there is a layer of insulating material which substantially fills the free intermediate space between the portion of tube and the electrode of opposite polarity and

the axial length of which is shorter than the axial length of the piece of tube; and

f. at the ends of the current carrying members there are springs which press the group of electrodes together regardless of the pressure on the sleeves.

2. A galvanic cell according to claim 1, wherein in addition to the springs which press the stack of electrodes together, there are other springs stronger than the aforesaid springs, and which exert on the sleeves a pressure which presses them on the edges of the contact holes.

3. A galvanic cell according to claims 1 or 2, wherein the separators comprise holes the diameter of which corresponds substantially to the throughbore in the electrodes.

4. A galvanic cell according to any one or more of claims 1 to 3, wherein the terminal pillar has a shoulder in the region of the end plate.

5. A galvanic cell according to any one or more of claims 1 to 4, wherein the compressed zone of the electrode is provided in the region of the contact hole concentrically of the central point of the contact hole and is of larger diameter than the insulating sleeve.

6. A galvanic cell substantially as described herein with reference to and as illustrated in the accompanying drawings.

Printed in the UK for HMSO, D8818935, 11/86, 7102.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.